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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): H. KOBAYASHI et al

Serial No. : 10/025,281

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For : IMAGING APPARATUS AND OPTICAL SCREEN UNIT

Art Unit :

Examiner :

CERTIFICATE OF MAILING

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Si Dianne Franklin

Dated: May 3, 2002

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PRELIMINARY AMENDMENT

Assistant Commissioner of Patents
Washington, D.C. 20231

S I R :

Please preliminarily amend the above-identified application as set forth hereinbelow.

IN THE SPECIFICATION:

Please replace the paragraph at page 10, lines 15-16 with the following:

Various embodiments of the present invention will be described with reference to the drawings below.

Please delete the paragraph at page 10, line 17 through page 13, line 13.

Please replace the paragraph at page 13, lines 14-23 with the following:

According to a first embodiment, an image is, as shown in Fig. 1 and Fig. 2, projected from an image projector 1 on the major surface of an optical screen unit 3. The optical screen unit 3 has an optical plate 7 and, for example, two optical sheets 5 and 6 supported on a frame member 4. The optical plate 7, which is rigid, is located on the side of the frame member 4 facing an observer. The two optical sheets 5 and 6, which are flexible, are brought into close contact with each other over the major surface of the optical plate 7.

And please replace the paragraph at page 22, lines 2-6 with the following:

The other ends of the resilient members 12a are fixed to two substantially central points on the short sides of the inner surface of the frame member 4. More particularly, tensile force is applied to the optical sheets rightward and leftward.

IN THE ABSTRACT:

Please replace the Abstract of the Disclosure at page 47 of the specification with the following:

ABSTRACT

An image forming system is provided which includes an optical sheet and an image projector. The optical sheet is constructed by joining a plurality of sheet members with adjoining sheet members meeting to form a joint line. The image projector produces an image and projects the image to the optical sheet through a projection optical system. The relative positional relationship between the image projector and optical sheet is such that the optical axis of the projection optical system included in the image projector perpendicularly intersects the joint line in the optical sheet. Thus, reflection or scattering of light at the joint line is minimized.

IN THE CLAIMS:

Please substitute amended claims 1-24 as follows:

1. (Amended) An image forming system comprising:

an optical sheet having a plurality of sheet members joined such that margins of each pair of adjoining sheet members meet to form a joint line; and

a number of image projectors each producing an image or a part of an image and projecting the image or the part of the image to said optical sheet through a projection optical system;

wherein when a number of joint lines are formed and the joint lines do not cross each other in said optical sheet, the number of image projectors is equal to or larger than the number of joint lines, and when the joint lines cross each other at a node in said optical sheet, the number of image projectors is equal to or larger than at least a number of nodes, and

wherein said image projectors are positioned such that: (i) when only one node exists within a field in said optical sheet corresponding to the image or the part of the image projected from an image projector, an optical axis of a projection optical system meets the node to fit a normal on a major surface of said optical sheet, and (ii) when no node exists and only one joint line is formed, the optical axis of the projection optical system intersects the joint line at a point and is contained in a plane defined with the normal on the major surface at the point and the joint line.

2. (Amended) The image forming system according to Claim 1, wherein at least one node is formed by convergence of four joint lines that are orthogonal to one another in the form of a cross or three joint lines that are orthogonal to one another in the form of a letter T.

3. (Amended) The image forming system according to Claim 1, wherein a plurality of joint lines are formed which are parallel to one another.

4. (Amended) An image forming system comprising:

an optical sheet having two sheet members joined with margins of the sheet members meeting to form a joint line, said sheet members being substantially planar; and

a plurality of image projectors each producing a part of an image and projecting the part of an image to said optical sheet through a projection optical sheet,

wherein optical axes of said plurality of image projectors are contained in planes defined by the joint line and a normal on a major surface of said optical sheet.

5. (Amended) An image forming system comprising:

an optical sheet having three or more sheet members joined such that margins of adjoining sheet members meet to form two or

more mutually parallel joint lines, said sheet members being substantially planar; and

a plurality of image projectors each producing part of an image and projecting the part of an image to said optical sheet through a projection optical system,

wherein one or more image projectors are opposed to each of the two or more joint lines, and

wherein said image projectors are positioned so that optical axes thereof will be contained in planes defined with the corresponding joint lines and a normal on a major surface of said optical sheet respectively.

6. (Amended) An image forming system comprising:

an optical sheet having a plurality of sheet members joined such that margins of adjoining sheet members meet to form respective joint lines and one or more nodes at each of which joint lines converge, said sheet members being substantially planar; and

one or more image projectors each producing part of an image and projecting the part of the image to said optical sheet through a projection optical system,

wherein one image projector corresponds to each of the one or more nodes, and

wherein an image projector corresponding to a node is positioned so that an optical axis of a projection optical system

included in the image projector will meet the node while fitting a normal on a major surface of said optical sheet at the node.

7. (Amended) The image forming system according to Claim 6, further comprising one or more image projectors corresponding to any points on the joint lines other than the nodes, wherein the image projectors corresponding to any points on the joint lines other than the nodes are positioned so that optical axes of projection optical systems included in the image projectors will be contained in planes defined with the normal on the major surface of said optical sheet at the points on the joint lines, and the joint lines.

8. (Amended) An image forming system comprising:

an optical sheet having a unique portion whose optical property is unique; and

an image projector for projecting an image to said optical sheet through a projection optical system,

wherein said image projector is positioned so that a solid angle formed with rays propagating from the projection optical system to the unique portion is minimized under a restriction on a predetermined positional relationship to said optical sheet.

9. (Amended) An optical screen unit having a major surface on which an image is projected, comprising:

an optical plate having rigidity;

at least one flexible optical sheet arranged over a major surface of said optical plate; and

a close contact means for bringing the major surface of said optical plate into close contact with a major surface of said optical sheet.

10. (Amended) The optical screen unit according to Claim 9, wherein said optical plate is curved so that the major surface thereof facing said optical sheet is a convex surface.

11. (Amended) The optical screen unit according to Claim 10, wherein the convex surface comprises a cylindrical surface.

12. (Amended) The optical screen unit according to Claim 10, wherein a maximum magnitude of projection of the convex surface attained when no stress is applied to said optical plate ranges from 2 mm to 100 mm.

13. (Amended) The optical screen unit according to Claim 9, further comprising a tensing means for applying a tensile force, which is oriented at least along the major surface of said optical screen unit, to said optical sheet.

14. (Amended) The optical screen unit according to Claim 10, wherein:

said close contact means includes tensing means for applying a tensile force, which is oriented along the major surface of said optical screen unit, to said optical sheet, and means for applying a pressing force, with which said optical sheet is pressed against the convex surface of said optical plate, to said optical sheet; and

said optical sheet to which the tensile force is applied is pressed against the convex surface of said optical plate.

15. (Amended) The optical screen unit according to Claim 14, further comprising a frame member that supports said optical plate, wherein said tensing means includes a resilient member having a first end supported on said frame member and a second end coupled to said optical sheet, to thereby exert the tensile force.

16. (Amended) The optical screen unit according to Claim 15, wherein a plurality of optical sheets are provided and tensed mutually independently by a plurality of resilient members, and tensile forces applied to the respective optical sheets are oriented in a same direction.

17. (Amended) The optical screen unit according to Claim 15, wherein:

a plurality of optical sheets are provided and tensed mutually independently by a plurality of resilient members;

a tensile force applied to an optical sheet located farthest from said optical plate among said plurality of optical sheets has a component oriented to approach said optical plate;

a tensile force applied to at least one optical sheet among said plurality of optical sheets except the farthest optical sheet has a component oriented to recede from said optical plate; and

a resultant force of tensile forces applied to said plurality of optical sheets has a component oriented to approach said optical plate.

18. (Amended) The optical screen unit according to Claim 15, wherein the convex surface of said optical plate comprises a cylindrical surface, and said resilient member tenses said optical sheet in a perimetric direction of the cylindrical surface of said optical plate.

19. (Amended) The optical screen unit according to Claim 15, wherein said resilient member tenses said optical sheet in radial directions from a center of the major surface of said optical sheet.

20. (Amended) The optical screen unit according to Claim 15, wherein said tensing means further includes a tensile force adjusting means that enables adjustment of the tensile force exerted by said resilient member.

21. (Amended) The optical screen unit according to Claim 9, wherein:

said optical sheet comprises a plurality of sheet members joined such that margins of adjoining sheet members meet to form respective joint lines; and

at least one of the joint lines is positioned so that an optical axis of a projection optical system included in the image projector, which projects light on said optical screen unit, will intersect the one joint line.

22. (Amended) The optical screen unit according to Claim 9, wherein:

said optical plate comprises a diffusing plate;

a plurality of optical sheets are provide; and

at least two of the optical sheets comprise lenticular lens sheets.

23. (Amended) The optical screen unit according to Claim 22, wherein a side of said diffusing plate to be brought into contact with said lenticular lens sheets is formed as a

diffusing surface, and a side of said diffusing plate opposite to the diffusing surface is processed to become anti-glare.

24. (Amended) The optical screen unit according to Claim 22, wherein a side of said diffusing plate to be brought into contact with said lenticular lens sheets is formed as a diffusing surface, and a side of said diffusing plate opposite to the diffusing surface is processed to become anti-reflection.

REMARKS

Consideration of this application as amended is respectfully requested.

The abstract has been amended to better comply with the requirements of MPEP 608.01(b), and the specification has been amended to correct minor informalities of which the undersigned has become aware. And it is noted that the paragraph at page 10, line 17 to page 13, line 13 has been deleted because this paragraph was essentially an identical repeat of the immediately preceding disclosure in the Brief Description of the Drawings.

In addition, the claims have been amended to make minor grammatical improvements and to correct minor antecedent basis problems so as to put the claims in better U.S. form

Submitted herewith are marked copies of the changed pages of the abstract, specification and claims to show that no new matter has been added.

It is respectfully requested that the amendments to the abstract, specification, and claims be approved and entered.

And it is respectfully submitted that the amendments to the claims are not related to patentability and do not narrow the scope of the claims either literally or under the doctrine of equivalents.

In view of the foregoing, it is respectfully requested that prosecution on the merits proceed in light of this Preliminary Amendment.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,

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VERSION MARKED TO SHOW CHANGES MADE

joint lines extended vertically and four joint lines extended laterally;

Fig. 23 is a side view showing an image forming system in accordance with the embodiment in which images are projected from nine image projectors, which are arranged in the form of a lattice, on an optical sheet that has six joint lines extended vertically and four joint lines extended laterally; and

Fig. 24 is a front view showing an arrangement of partial images projected from nine image projectors, which are arranged in the form of a lattice, on an optical sheet that has six joint lines extended vertically and four joint lines extended laterally.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 Various embodiments
~~An embodiment~~ of the present invention will be
16 described with reference to the drawings below.
17 ~~Fig. 1 to Fig. 24 are concerned with one embodiment of~~ the present invention. Fig. 1 is a side view showing the structure of an optical screen unit on which an image is projected from an image projector. Fig. 2 is a perspective view showing the arrangement of optical sheets and an optical plate which are included in the optical screen unit on which an image is projected from the image projector. Fig. 3A and Fig. 3B are a plan view and a front view showing

USSN 10/025,281

a relationship between a joint line on the optical screen unit and the optical axis of the image projector. Fig. 4 is an enlarged view showing the arrangement of the optical sheets and optical plate in a direction in which they are layered. Fig. 5A and Fig. 5B are a front view and a side view showing a first example of a structure for resiliently supporting the optical sheets on a frame member. Fig. 6A and Fig 6B are a front view and a side view showing a second example of the structure for resiliently supporting the optical sheets on the frame member. Fig. 7A and Fig. 7B are a front view and a side view showing a third example of the structure for resiliently supporting the optical sheets on the frame member. Fig. 8A and Fig. 8B are a front view and a side view showing a variant of the third example shown in Fig. 7A and Fig. 7B. Fig. 9A and Fig. 9B are a front view and a side view showing a fourth example of the structure for resiliently supporting the optical sheets on the frame member. Fig. 10 is an enlarged front view showing the structure for resiliently supporting the optical sheets on the frame member with a tension variation mechanism added thereto. Fig. 11 is a sectional view showing the internal structure of the tension variation mechanism. Fig. 12 is a perspective view showing an image forming system in which an image is projected from an image projector on an optical sheet having one joint line. Fig. 13 is a plan view showing

10/025,781

the image forming system in which an image is projected from an image projector on an optical sheet having one joint line. Fig. 14 is a side view showing the image forming system in which an image is projected from an image projector on an optical sheet having one joint line. Fig. 15 is an enlarged plan view showing a desirable positional relationship between a joint line and rays projected from an image projector. Fig. 16 is an enlarged plan view showing an undesirable positional relationship between a joint line and rays projected from an image projector. Fig. 17 is a perspective view showing an image forming system in which three projectors project images on an optical sheet having one joint line. Fig. 18 is a plan view showing the image forming system in which three image projectors project images on an optical sheet having one joint line. Fig. 19 is a side view showing the image forming system in which three image projectors project images on an optical sheet having one joint line. Fig. 20 is a perspective view showing an image forming system in which images are projected by nine image projectors arranged in the form of a lattice on an optical sheet having three parallel joint lines. Fig. 21 is a plan view showing the image forming system in which images are projected by nine image projectors arranged in the form of a lattice on an optical sheet having three parallel joint lines. Fig. 22 is a

10/025, 281

~~perspective view showing an image forming system in which~~ images are projected by nine image projectors arranged in the form of a lattice on an optical sheet 27 having six joint lines extended vertically and four joint lines extended laterally. Fig. 23 is a side view showing an image forming apparatus in which images are projected by nine image projectors arranged in the form of a lattice on an optical sheet 27 having six joint lines extended vertically and four joint lines extended laterally. Fig. 24 is a front view showing the arrangement of partial images projected from nine image projectors, which are arranged in the form of a lattice, on the optical sheet 27 having six joint lines ~~extended vertically and four joint lines extended laterally.~~

According to a first embodiment, an ~~An~~ image is, as shown in Fig. 1 and Fig. 2, projected from an image projector 1 on the major surface of an optical screen unit 3. The optical screen unit 3 has an optical plate 7 and, for example, two optical sheets 5 and 6 supported on a frame member 4. The optical plate 7, which ~~that~~ is rigid, is located on the side of the frame member 4 facing an observer. The two optical sheets 5 and 6, which ~~that~~ are flexible, are brought into close contact with each other over the major surface of the optical plate 7.

The optical plate 7 is formed with an acrylic plate or the like having a predetermined thickness. The optical plate 7 is rigid enough to hold the curved surface intact

10/025,281

supporting pieces 11.

The other ends of the resilient members ~~12~~ 12a are fixed to two substantially central points on the short sides of the inner surface of the frame member 4. More particularly, tensile force is applied to the optical sheets rightward and leftward.

Owing to the structure, the magnitude of close contact of the optical sheets 5 and 6 with the optical plate 7 can be improved.

Next, referring to Fig. 9A and Fig. 9B, a description will be made on a fourth example of the structure for bringing the optical sheets 5 and 6 into close contact with the optical plate 7 by applying tensile force to the optical sheets.

As mentioned above, the optical plate 7 is fixed to and supported on the frame member 4 by means of an appropriate supporting structure.

Next, the optical sheets 5 and 6 have supporting pieces 11 attached to, for example, the center points of the short and long sides thereof and to the corners thereof. One end of a resilient member 12 that is, for example, a helical tension spring, is fixed to each of the eight supporting pieces 11.

The other ends of the resilient members 12 are, as shown in Fig. 9A, fixed to the center points of the long and

WHAT IS CLAIMED IS:

1. An image forming system comprising:

an optical sheet having a plurality of sheet members joined ~~with the~~ such that margins of each pair of adjoining sheet members ~~met as a~~ meet to form a joint line ~~so as to have one or more joint lines~~; and

a number of image projectors each producing an image or a part of an image and projecting the image or the part of ~~an~~ the image to said optical sheet through a projection optical system; wherein when a number of joint lines are formed and the joint lines do not cross each other in said optical sheet, the number of image projectors ~~being~~ is equal to or larger than the number of joint lines, and when the joint lines cross each other at a node in said optical sheet, the number of image projectors ~~being~~ is equal to or larger than at least ~~the~~ a number of nodes, and

wherein said image projectors are positioned ~~to cope with either of a first case where~~ such that: (i) when only one node exists within a field in said optical sheet corresponding to the image or the part of the image projected from an image projector, ~~a second case where no node exists but only one joint line exists, or a third case where no joint line exists; in said first case,~~ an optical axis of a projection optical system meets the node to fit ~~the~~ a normal on ~~the~~ a major surface of said optical sheet, and (ii) when no node exists and only one joint line is formed, ~~in said second case,~~ the optical axis of ~~a~~ the projection optical system intersects the

10/025,281

joint line at a point and is contained in a plane defined with the normal on the major surface at the point and the joint line.

2. The image forming system according to Claim 1, wherein ~~the~~ at least one node is formed ~~with~~ by convergence of four joint lines that are orthogonal to one another in the form of a cross or three joint lines that are orthogonal to one another in the form of a letter T.

3. The image forming system according to Claim 1, wherein ~~the~~ a plurality of joint lines are formed which are parallel to one another.

4. An image forming system comprising:

an optical sheet having two sheet members joined with ~~the~~ the margins of ~~adjoining~~ sheet members ~~not as~~ meeting to form a joint line ~~so as to have one joint line~~, ~~and~~ said sheet members being substantially planar; and

a plurality of image projectors each producing a part of an image and projecting the part of an image to said optical sheet through a projection optical sheet,

wherein ~~the~~ optical axes of said plurality of image projectors are contained in planes defined ~~with~~ by the joint line and ~~the~~ a normal on ~~the~~ a major surface of said optical sheet.

10/025,281

5. An image forming system comprising:

an optical sheet having three or more sheet members joined ~~with the~~ such that margins of adjoining sheet members ~~met as a joint line so as to have~~ meet to form two or more mutually parallel joint lines, ~~and~~ said sheet members being substantially planar; and

a plurality of image projectors each producing part of an image and projecting the part of an image to said optical sheet through a projection optical system, wherein one or more image projectors ~~being~~ are opposed to each of the two or more joint lines, and

wherein said image projectors are positioned so that ~~the~~ optical axes thereof ~~will be~~ are contained in planes defined with the corresponding joint lines and ~~the~~ a normal on ~~the~~ a major surface of said optical sheet respectively.

6. An image forming system comprising:

an optical sheet having a plurality of sheet members joined ~~with the~~ such that margins of adjoining sheet members ~~met as a joint line so as to have a plurality of~~ meet to form respective joint lines and one or more nodes at each of which joint lines converge, ~~and~~ said sheet members being substantially planar; and

one or more image projectors each producing part of an image and projecting the part of ~~an~~ the image to said optical sheet through a projection optical system, wherein one image

10/025,281

projector corresponding to each of the one or more nodes, and

wherein an image projector corresponding to a node is positioned so that an optical axis of a projection optical system included in the image projector will meet the node while fitting a normal on a major surface of said optical sheet at the node.

7. The image forming system according to Claim 6, further comprising one or more image projectors corresponding to any points on the joint lines other than the nodes, wherein the image projectors corresponding to any points on the joint lines other than the nodes are positioned so that optical axes of projection optical systems included in the image projectors will be contained in planes defined with the normal on the major surface of said optical sheet at the points on the joint lines, and the joint lines.

8. An image forming system comprising:

an optical sheet having a unique portion whose optical property is unique; and

an image projector for projecting an image to said optical sheet through a projection optical system,

wherein said image projector is positioned so that a solid angle formed with rays propagating from the projection

optical system to the unique portion ~~will be~~ is minimized under a restriction on a predetermined positional relationship to said optical sheet.

9. An optical screen unit having a major surface on which an image is projected, comprising:

an optical plate having rigidity;

at least one ~~or more~~ flexible optical sheet ~~being~~ arranged over ~~the~~ a major surface of said optical plate ~~and being flexible~~; and

a close contact means for bringing the major surface of said optical plate into close contact with ~~the~~ a major surface of said optical sheet.

10. The optical screen unit according to Claim 9, wherein said optical plate is curved so that the major surface thereof facing said optical sheet ~~will be~~ is a convex surface.

11. The optical screen unit according to Claim 10, wherein the convex surface ~~is~~ comprises a cylindrical surface.

12. The optical screen unit according to Claim 10, wherein a maximum magnitude of projection of the convex surface attained ~~with~~ when no stress is applied to said optical plate ranges from 2 mm to 100 mm.

10/025,281

13. The optical screen unit according to Claim 9, further comprising a tensing means ~~that applies~~ for applying a tensile force, which is oriented at least along the major surface of said optical screen unit, to said optical sheet.

14. The optical screen unit according to Claim 10, wherein: said close contact means includes ~~close contact~~ tensing means ~~that applies~~ for applying a tensile force, which is oriented along the major surface of said optical screen unit, to said optical sheet, and ~~that applies~~ means for applying a pressing force, with which said optical sheet is pressed against the convex surface of said optical plate, to said optical sheet, and said optical sheet to which the tensile force is applied is pressed against the convex surface of said optical plate.

15. The optical screen unit according to Claim 14, ~~further comprising a frame member that supports said optical~~ plate, wherein said tensing means includes a resilient member having ~~one~~ a first end ~~thereof~~ supported on said frame member, ~~having the other~~ and a second end ~~thereof~~ coupled to said optical sheet, ~~and thus exerting~~ to thereby exert the tensile force.

16. The optical screen unit according to Claim 15, wherein a plurality of optical sheets are ~~included~~ provided and

10/025,281

tensed mutually independently by a plurality of resilient members, and tensile forces applied to the respective optical sheets are oriented in ~~the~~ a same direction.

17. The optical screen unit according to Claim 15, wherein:

a plurality of optical sheets are ~~included~~ provided and tensed mutually independently by a plurality of resilient members;

a tensile force applied to an optical sheet located farthest from said optical plate among said plurality of optical sheets has a component oriented to approach said optical plate;

a tensile force applied to at least one optical sheet among said plurality of optical sheets except the farthest optical sheet has a component oriented to recede from said optical plate; and

a resultant force of tensile forces applied to said plurality of optical sheets has a component oriented to approach said optical plate.

18. The optical screen unit according to Claim 15, wherein the convex surface of said optical plate ~~is~~ comprises a cylindrical surface, and said resilient member tenses said optical sheet in ~~the~~ a perimetric direction of the cylindrical surface of said optical plate.

10/025,281

19. The optical screen unit according to Claim 15, wherein said resilient member tenses said optical sheet in radial directions from ~~the~~ a center of the major surface of said optical sheet.

20. The optical screen unit according to Claim 15, wherein said tensing means further includes a tensile force adjusting means that enables adjustment of the tensile force exerted by said resilient member.

21. The optical screen unit according to Claim 9, wherein:

said optical sheet ~~is constructed by joining~~ comprises a plurality of sheet members joined such that ~~with the~~ margins of adjoining sheet members ~~not~~ meet to form respective joint lines; and

at least one of ~~one or more~~ the joint lines ~~formed by joining the plurality of sheet members~~ is positioned so that ~~the~~ an optical axis of a projection optical system included in the image projector, which projects light on said optical screen unit, will intersect the one joint line.

22. The optical screen unit according to Claim 9, wherein, said optical plate ~~is~~ comprises a diffusing plate, a plurality of optical sheets are ~~included~~ provided, and at least two of the

10/025,281

optical sheets ~~are realized with~~ comprise lenticular lens sheets.

23. The optical screen unit according to Claim 22, wherein ~~the~~ a side of said diffusing plate to be brought into contact with said lenticular lens sheets is formed as a diffusing surface, and ~~the~~ a side ~~thereof~~ of said diffusing plate opposite to the diffusing surface is processed to become anti-glare.

24. The optical screen unit according to Claim 22, wherein ~~the~~ a side of said diffusing plate to be brought into contact with said lenticular lens sheets is formed as a diffusing surface, and ~~the~~ a side ~~thereof~~ of said diffusing plate opposite to the diffusing surface is processed to ~~become anti-reflection~~.

10/025,281

ABSTRACT ~~OF THE DISCLOSURE~~

~~The present invention provides an~~ An image forming system is provided which includes ~~consisting mainly of~~ an optical sheet and an image projector. The optical sheet is constructed by joining a plurality of sheet members with adjoining sheet members ~~met~~ meeting to form a joint line. The image projector produces an image and projects the image to the optical sheet through a projection optical system. The relative positional relationship between the image projector and optical sheet is such that the optical axis of the projection optical system included in the image projector perpendicularly intersects the joint line in the optical sheet. Thus, reflection or scattering of light at the joint line is minimized.

10/025,281